METHOD AND APPARATUS FOR MAKING A TISSUE PAPER WITH IMPROVED TACTILE QUALITIES WHILE IMPROVING THE REEL-UP PROCESS FOR A HIGH BULK WEB

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional of U.S. Application No. 10/167,336, filed June 11, 2002, which is hereby incorporated herein in its entirety by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to paper-making machinery and, more particularly, to a paper-making machine and associated method for making a tissue paper with improved tactile qualities while improving the reel-up process.

Description of Related Art

In the production of tissue for use in personal hygiene products and the like, it is desired to produce a tissue with good tactile qualities (i.e., silky and soft to the touch) while also achieving a high machine speed and efficiency. The speed and efficiency are often limited by the performance of the dry end of the machine between the final dryer and the winding station or reel-up. Tissue is extremely delicate and difficult to handle, especially at high machine speeds. For example, in some instances, the tissue web is dried by a through air dryer ("TAD"), wherein a through air drying fabric ("TAD fabric") is used to transport the web through the TAD. The TAD fabric is generally an open structured drying fabric. Accordingly, the web will tend to become drawn into the structure of the TAD fabric as the web is processed through the TAD and other processing devices such as, for instance, a molding device, in order to produce a

structured three-dimensional fiber network. However, separating the tissue web from the TAD fabric without damaging the web then becomes a difficult and sensitive task.

In addition, due to the generally delicate nature of the tissue web, excessive transfers and handling of the web in the dry end of the machine may result in damage to the web. Such detrimental results may also occur if the web is unsupported between components within the dry end. Further, if a bulky tissue web is produced in the paper-making process, the capacity of the roll on which the web is wound may be undesirably low since the web cannot be tightly wound onto the roll. A loosely wound roll is relatively more difficult to handle and may be undesirably prone to, for example, telescoping with respect to the roll.

Thus, there exists a need for a method and apparatus directed to a dry end of a tissue paper-making machine for making a tissue web providing improved tactile qualities while improving the handling of the tissue web in the dry end. Such an apparatus and method should desirably be capable of addressing the issue of separating the tissue web from a TAD fabric efficiently and at high speed, but without damage. Further, such an apparatus and method should provide for minimal transfers and other handling of the tissue web while providing support for the tissue web throughout the dry end. In addition, the apparatus and method should be directed to reducing the bulk of the tissue web, again with minimal handling and while providing the desired improved tactile quality, in order to increase roll capacity and facilitate handling of the rolls.

BRIEF SUMMARY OF THE INVENTION

The above and other needs are met by the present invention which, in one embodiment, provides a dry end section for a paper-making machine for producing a high-bulk tissue. Such a machine includes a through-air dryer adapted to finally dry a paper web and a through-air drying fabric configured to transport the web through the through-air dryer. A separating device is also included for facilitating separation of the web from the through-air drying fabric, and the machine comprises a reel configured to receive the web. A single permeable fabric is wrapped about the separating device and extends to the reel, wherein the single permeable fabric is configured to receive the web

directly thereon from the through-air drying fabric and to transport the web directly to the reel without free draw of the web.

Another advantageous aspect of the present invention comprises a dry end section for a paper-making machine for producing a high-bulk tissue. Such a machine includes a through-air dryer adapted to finally dry a paper web and a through-air drying fabric configured to transport the web through the through-air dryer. A separating device is further included for separating the web from the through-air drying fabric such that the web is received directly on the separating device. A roll is disposed adjacent to the separating device so as to define a nip therebetween and to form a web-compressing device. A single fabric is wrapped about the roll, passes through the nip, and extends to a reel configured to receive the web, wherein the single fabric is configured to receive the web thereon at the nip and to transport the web from the nip to the reel, at which point the web is transferred directly from the single fabric to a reel without free draw of the web.

Still another advantageous aspect of the present invention comprises a dry end section for a paper-making machine for producing a high-bulk tissue. Such a machine includes a through-air dryer adapted to finally dry a paper web and a through-air drying fabric configured to transport the web through the through-air dryer. A separating device is also included for separating the web from the through-air drying fabric, wherein the separating device is configured to receive the web directly thereon. A reel having a reel drum disposed adjacent thereto forms a reel-up for receiving the web from the separating device. A non-contacting support system is disposed between the separating device and the reel-up, wherein the non-contacting support system is configured to receive the web directly from the separating device and to transport the web directly to the reel-up.

Yet other advantageous aspects of the present invention comprise methods for making a tissue with enhanced tactile quality and facilitating reel-up of the tissue in a dry end of a tissue paper-making machine, each method corresponding to the processing of a tissue web with the respective dry end section for a paper-making machine for producing a high bulk tissue as described herein, as will be appreciated by one skilled in the art.

Thus, embodiments of the present invention provide a method and apparatus directed to a dry end of a tissue paper-making machine for making a tissue web providing improved tactile qualities while improving the handling of the tissue web in the dry end.

Embodiments of the present invention further address the issue of separating the tissue web from a TAD fabric efficiently and at high speed, but without damage and while minimizing transfers and other handling of the tissue web, by using a suction roll for separating the web from the TAD fabric, wherein the suction roll is disposed adjacent to an additional roll to also form a web-compressing device. The web is then wound directly onto the roll or transported directly thereto by a single fabric passing through the web-compressing device. Accordingly, support is provided for the tissue web throughout the dry end, and runability of the dry end is facilitated, while the bulk of the tissue web is reduced in order to provide increased roll capacity and more efficient handling of the rolls. In addition to improving the tactile quality of the tissue web, embodiments of the present invention reduce the number of fabrics, and components associated therewith, used in the dry end, thereby simplifying the paper-making machine, reducing the handling of the web, and reducing the cost and maintenance requirements of the machine. Therefore, the present invention provides distinct advantages as further detailed herein.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

Having thus described the invention in general terms, reference will now be made to the accompanying drawings, which are not necessarily drawn to scale, and wherein:

FIG. 1A is a cross-sectional schematic of a dry end section for a paper-making machine for producing a high-bulk tissue according to one embodiment of the present invention showing an inward flow TAD and a web-compressing device formed between a suction roll having a fabric wrapped thereabout and an adjacent roll;

FIG. 1B is a cross-sectional schematic of a dry end section for a paper-making machine for producing a high-bulk tissue according to one embodiment of the present invention showing an outward flow TAD and a web-compressing device formed between a suction roll having a fabric wrapped thereabout and an adjacent roll;

FIG. 2 is a cross-sectional schematic of a dry end section for a paper-making machine for producing a high-bulk tissue according to an alternate embodiment of the present invention showing an inward flow TAD and a web-compressing device formed between a suction roll having a fabric wrapped thereabout and an adjacent roll;

FIG. 3 is a cross-sectional schematic of a dry end section for a paper-making machine for producing a high-bulk tissue according to another alternate embodiment of the present invention showing a web-compressing device formed about the web along the dry end section between the suction roll and the reel;

FIGS. 4 and 5 are cross-sectional schematics of still further alternate embodiments of the present invention, each showing a dry end section for a paper-making machine for producing a high-bulk tissue having a web-compressing device formed between a suction roll and an adjacent roll having a fabric wrapped thereabout; and

FIG. 6 is a cross-sectional schematic of yet another alternate embodiment of the present invention showing a dry end section for a paper-making machine for producing a high-bulk tissue, the dry end section including an inward flow TAD and the web being transported between a suction roll and a reel nip by air devices.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

FIGS. 1A-B, 2, and 3 schematically illustrate embodiments of a dry end of a paper-making machine, the dry end being indicated by the numeral **10**, according to the present invention. The dry end **10** includes at least one through air dryer ("TAD") **20** configured to finally dry a tissue paper web **30**. Though the embodiments of the present invention are generally described herein in terms of a single TAD **20**, the dry end **10** may include a plurality of through-air dryers. Further, one skilled in the art will appreciate that the web **30** may be pre-dried or otherwise processed through other dryers before being transferred to the TAD **20**. For example, the web **30** may be pre-dried on a Yankee dryer (not shown) and then creped therefrom before being transferred to a TAD **20** for

final drying. In other instances, the web **30** may be pre-dried by another type of dryer such as, for example, an impingement dryer (not shown). Thus, embodiments of the present invention describing a dry end **10** are not intended to be restrictive with respect to the processing of the web **30** prior to the web **30** being finally dried by the through air dryer **20**.

As shown in **FIGS. 1A, 2, and 3**, the TAD **20** may be configured to have an inward flow or, in some instances, to have an outward flow if the drying air, as shown in **FIGS. 1B**. Accordingly, one skilled in the art will appreciate that any of the embodiments described herein may implement either an inward flow TAD or an outward flow TAD within the spirit and scope of the present invention. As such, it will be understood that both TAD alternatives are expressly included herein for each embodiment of the present invention, even though both TAD alternatives may not be specifically mentioned or illustrated. The TAD **20** is further configured to have a through air drying fabric ("TAD fabric") **40** wrapped thereabout for receiving the web **30** thereon and transporting the web **30** through the TAD **20**. In some cases, a transfer device **50** may be disposed adjacent to the TAD fabric **40** about where the web **30** is received in order to facilitate the transfer of the web **30** onto the TAD fabric **40**. The TAD fabric **40** is generally an open structured drying fabric and the web **30** will tend to become drawn into the structure of the TAD fabric **40** as the web **30** is processed through the TAD **20** and other processing devices such as, for instance, a molding device **60** which, in one embodiment, is disposed before the TAD **20** and adjacent to the TAD fabric **40**. Such a molding device **60** is configured to impart suction on the web **30** through the TAD fabric **40** so as to draw the web **30** into the fabric structure and form a structured three-dimensional fiber network. According to one embodiment of the present invention, the finally-dried web **30** has a basis weight of between about 10 g/m^2 and about 50 g/m^2 and a dry caliper of between about 0.2 mm and about 0.5 mm, and thus a density of between about 20 kg/m^3 and about 250 kg/m^3, after leaving the TAD **20**.

A tissue web **30** is extremely delicate and difficult to handle, especially at high machine speeds. As such, following the drying process, it is typically difficult to separate the tissue web **30** from a TAD fabric **40** into which the web **30** has become drawn. Further, a tissue web **30** is at less risk of damage if handled by fewer machine

components and is supported (i.e., not subjected to free draw) during the drying process. Thus, according to one advantageous aspect of the present invention, the web **30** is separated from the TAD fabric **40**, following final drying of the web **30** by the TAD **20**, by a separating device **90** having a permeable fabric **130** wrapped thereabout. The separating device **90** may comprise, for example, a suction-configured reel drum or a suction roll (referred to herein as "suction roll **90**") for separating the web **30** from the TAD fabric **40**. More particularly, the TAD fabric **40** is guided about the TAD **20** by a plurality of turning rolls **100**. Following final drying of the web **30** by the TAD **20**, the TAD fabric **40** is directed so as to run tangentially to the suction roll **90** so as to define a web transfer point **110** between the TAD fabric **40** and the permeable fabric **130**. Thus, the suction roll **90** imparts suction through the permeable fabric **130**, as discussed below, so as to facilitate the transfer of the web **30** thereto. Further, in order to facilitate the running of the web **30** through the described dry end **10** and separation of the web **30** from the TAD fabric **40**, an air-emitting device **120** such as, for example, an air knife or an air shower, may be disposed adjacent to the TAD fabric **40** about the web transfer point **110**. The air-emitting device **120** is directed/configured to emit air through the TAD fabric **40** and against the web **30** so as to provide assistance in separating the web **30** from the TAD fabric **40** only as the web **30** is initially being threaded through the dry end **10**.

Accordingly, the leading edge of the web **30** is first separated from the TAD fabric **40** by the suction roll **90** in conjunction with the air-emitting device **120**, wherein the permeable fabric **130** is configured to allow the suction roll **90** to apply the suction therethrough to the tissue web **30**. Once the web **30** is separated from the TAD fabric **40**, the web **30** is received directly on the permeable fabric **130** and the air-emitting device **120** is deactivated. The permeable fabric **130** then solely transports the web **30** from the suction roll **90** to the reel **70**. That is, in advantageous embodiments of the present invention, only one permeable fabric **130** extends from the suction roll **90** to the reel **70** and only that permeable fabric **130** contacts and supports the web **30** therebetween. The web **30** is further transported from the TAD fabric **40** to the reel **70** without free draw. As such, once the web **30** is dried and separated from the TAD fabric **40**, the web **30** is wound onto a reel **70** with minimal handling. More particularly, as shown in **FIGS. 1A**

and 1B, the permeable fabric **130** wraps about the separating device **90** and about one or more turning rolls **100** such that the permeable fabric **130** runs adjacent to the reel **70** and tangentially thereto. In such a configuration, the permeable fabric **130** supports the reel **70** during the winding process, forming a "soft nip" therewith, wherein the pressure in the soft nip may be selectively controlled so as to control the tension in the web **30** as it is wound onto the reel **70**.

In instances where a high bulk tissue web **30** is produced, such a web **30**, for example, may lessen the capacity of a roll, may be more difficult to handle, and may be prone to telescoping on the roll. Accordingly, it may be advantageous to reduce the bulk of the web **30** prior to winding the web **30** onto the roll. Compressing the web **30** in order to reduce the bulk thereof is usually accomplished through the use of a compression device defining a compression nip between adjacent rolls. Such a compression device comprises, for example, a calender used in the manufacture of card stock. However, due to the fragile nature of the tissue web **30**, it is very difficult to thread an unsupported tissue web through such a compression device. In addition, a calender used in the production of card stock is typically configured to impart smoothness or gloss to the card stock surface, which is not necessarily desired with a tissue paper. For a tissue paper, a good tactile quality, softness, and silkiness are some of the more desirable characteristics.

As shown in **FIGS. 1A and 1B**, a roll **140** may be added and disposed adjacent to the suction roll **90** so as to form a web-compressing device defining a nip **150** therebetween. Such a nip **150** may be adjustable to provide the necessary pressure for compressing the web **30**, which, in one embodiment, is a linear load of between about 200 N/m and about 800 N/m that reduces the web **30** in thickness by about 20% to about 50% with respect to the pre-compressed thickness of the web **30**. Since the web **30** is received directly on the permeable fabric **130** from the TAD fabric **40**, the permeable fabric **130** supports and transports the web **30** through the nip **150**. The roll **140** may be similar to a calender roll in that the surface thereof may be smooth. In the alternative, the surface of the roll **140** may also be patterned if a patterned structure is desired in the final web **30**.

However, when the web **30** is transported through a nip, the tendency of the web **30** will be to follow the smoother surface upon exiting the nip. Thus, the separating

device **90** may also be configured to facilitate running of the web **30**. For example, the suction roll **90** may comprise a perforated outer shell or mantle with one or more air devices disposed inside the mantle and in spaced apart relation with respect thereto. Such air devices may be configured according to the needs of the particular application and, for example, may be adjustable within the mantle or rotatable about the axis of the suction roll **90** to further facilitate adjustment of the suction roll **90** for different processes. The air devices may further be configured to provide suction or to emit air outwardly therefrom, as necessary. As such, the mantle and the air devices may be arranged such that suction or emitted air can be selectively provided along the circumference of the mantle and/or laterally across the mantle while the mantle is rotating and transporting the web **30**. For example, since it is desired to maintain the web **30** on the permeable fabric **130** through the nip **150** and to the reel **70**, one or more air devices may be placed within the mantle of the suction roll **90** to provide suction along the circumference of the mantle from the web transfer point **110** to after the nip **150** so as to maintain the web **30** on the permeable fabric **130** therebetween.

In some situations, the necessary suction through the mantle of the suction roll **90**, and the permeable fabric **130**, may vary depending on the position of the web **30** with respect thereto. For example, suction is required about the web transfer point **110** to separate the web **30** from the TAD fabric **40** and to transfer the web **30** to the permeable fabric **130**. However, a higher suction may be initially required when the leading edge of a new web **30** is to be separated from the TAD fabric **40**, wherein the air-emitting device **120** may be simultaneously activated to facilitate the initial transfer of the web **30** to the permeable fabric **130**. In one embodiment, such a higher suction may be on the order of, for example, 30 kPa. After the initial threading of the web **30**, a lesser suction may be required to maintain the web **30** on the suction roll **90** and the permeable fabric **130**, from the web transfer point **110** and through the reel nip **150**. In one embodiment, such a lesser suction may be on the order of, for example, 5-10 kPa. Still further, in some instances, the air devices may be configured with respect to the mantle so as to provide suction or air emission across the entire width, or at one or more selected zones across the width of the mantle, the selected zones thereby providing the necessary characteristic for the corresponding segment of the mantle while, for example, reducing the required

volume capacity of the air devices. Accordingly, the air devices may be appropriately and selectively controlled to provide the necessary conditions for the web **30** about the mantle of the suction roll **90**.

As shown in **FIG. 2**, a reel drum **160** may disposed adjacent to the reel **70** so as to form a reel nip **170** therebetween. In this manner, the reel drum **160** supports the reel **70** and thus comprises an alternate configuration for facilitating the winding the web **30** onto the reel **70**. A single permeable fabric **130** extends about the suction roll **90**, the reel drum **160**, and one or more turning rolls **100** such that only the single permeable fabric **130** transports the web **30** from the suction roll **90** to the reel **70** without free draw of the web **30**. That is, the single permeable fabric **130** extends about the suction roll **90** and cooperates therewith to separate the web **30** from the TAD fabric **40**. The permeable fabric **130** then receives the web **30** directly thereon and supports and transports the web **30** through the nip **150** of the web-compressing device formed between the suction roll **90** and the adjacent roll **140**. The suction roll **90** is further configured to provide suction along the mantle thereof from the web transfer point **110** to after the nip **150** for maintaining the web **30** on the permeable fabric **130** through the nip **150**. Following the nip **150**, one or more air devices **180** may be disposed adjacent to the permeable fabric **130** so as to facilitate runability. More particularly, the air device(s) **180** may be configured so as to retain the web **30** on the permeable fabric **130** as a new web **30** is being threaded into the dry end **10**. The air device(s) **180** may comprise, for example, a blowing device, such as a blow box, capable of creating a low pressure effect for retaining the web **30** on the permeable fabric **130**. In addition, one or more measuring devices **190** such as, for example, a scanner, may be disposed adjacent to the web **30**, opposite to the permeable fabric **130**, for measuring web properties such as, for instance, the thickness thereof, wherein such measurement devices **190** will be known and appreciated by one skilled in the art. The web **30** is then directed through the reel nip **170** and wound onto the reel **70**.

FIG. 3 illustrates an alternative embodiment to the embodiment shown in **FIG. 2**. As shown, instead of having a roll **140** disposed adjacent to the suction roll **90**, a web-compressing arrangement may be provided. The web-compressing arrangement includes a first roll **142a** disposed within the loop of the permeable fabric **130** opposite to the web

30, wherein the first roll **142a** is disposed between the suction roll **90** and the reel **70**. A second roll **142b** having a press fabric **145** wrapped thereabout is disposed in opposing relation to the first roll **142a** so as to form a nip **148** therebetween. The nip **148** is further formed such that the web **30** and the permeable fabric **130** pass therethrough , whereby the web **30** is compressed between the permeable fabric **130** and the press fabric **145**. Such a nip **148** may also be adjustable to provide the necessary pressure for compressing the web **30** to reduce the thickness thereof to the desired thickness.

Thus, the embodiments shown in **FIGS. 1A-B, 2, and 3** provide a compact dry end **10**, wherein the separating device **90** serves to separate the web **30** from the TAD fabric **40** while also serving as one of the rolls in a web-compressing device. Such a dry end **10** further allows the web **30** to be transferred from the TAD fabric **40** to the reel **70** without free draw. Minimal components forming the dry end **10** further provides a paper-making machine with a smaller footprint and also minimizes the necessary handling of the web **30**. In addition, the configuration of the suction roll **90** with a separate mantle and one or more air devices disposed therein allows the mantle to be selectively segmented into variable suction and variable air emission zones, while enabling, for example, a common suction roll **90** having a diameter of about 1000 mm to about 1400 mm to be used, thereby conserving costs with respect to the machine. The described embodiments thus contribute to provide improved runability of the web **30** without free draw so as to provide an improved dry end **10** for a paper-making machine.

FIGS. 4 and 5 illustrate further advantageous embodiments of the present invention. As shown, the suction roll **90** is configured to separate the web **30** from the TAD fabric **40** and to receive the web **30** directly thereon. The roll **140** is disposed adjacent to the suction roll **90** so as to form the web-compressing device, the rolls **90, 140** defining the nip **150** therebetween. One skilled in the art will appreciate, however, that, in some instances, a turning roll **100** about which the TAD fabric **40** is wrapped may be disposed adjacent to the suction roll **90** so as to form a second nip as part of a double nip web-compressing device (not shown), wherein that turning roll **100** may, in some situations, be configured as an air-emitting device so as to facilitate the transfer of the web **30** to the suction roll **90** following the second nip. Following the nip **150**, the single fabric **130** is wrapped about the roll **140** and extends about one or more turning rolls **100**

to support the reel **70** for winding the web **30** thereon. Accordingly, the web **30** is received directly on the suction roll **90**, wherein the suction roll **90** then transports the web **30** into the nip **150**. At the nip **150**, the web **30** is transferred to the fabric **130**, which thereafter supports and transports the web **30** to the reel **70** such that the web **30** is transported from the TAD fabric **40** to the reel **70** without free draw thereof. In order to retain the web **30** on the suction roll **90** between the web transfer point **110** and the nip **150**, the suction roll **90** may be configured to provide suction about the portion of the mantle extending therebetween, as previously described. Further, according to various embodiments of the present invention, the roll **140** may be configured for suction as described herein and the single fabric **130** may thus be permeable or, in the alternative, the roll **140** may be a solid roll and the single fabric **130** may be smooth and impermeable.

Though the suction from the suction roll **90** is intended to facilitate the transportation of the web **30** through the dry end **10**, separation of the web **30** from the TAD fabric **40** and transfer of the web **30** to the suction roll **90**, as well as direction of the web **30** into the nip **150**, may be further assisted by one or more blower devices **200** such as, for example, an air knife. More particularly, one air knife **200** may be directed toward the web transfer point **110** on the downstream side thereof to facilitate transfer of the web **30** onto the suction roll **90**, while another air knife **200** may be directed toward the nip **150** from the upstream side thereof in order to direct the web **30** into the nip **150**. In addition, in order to further concentrate the air streams emitted by the respective air knives **200**, as well as to protect the web **30** from the air streams, a suitably shaped screen **210** may be disposed between the portion of the suction roll **90** carrying the web **30** and the air knives **200**.

FIG. 6 illustrates another alternate embodiment, wherein the suction roll **90** is disposed adjacent to the TAD fabric **40** so as to separate the web **30** therefrom, wherein the web **30** is transferred directly onto the suction roll **90**. A reel drum **160** is disposed adjacent to the reel **70** so as to form a reel nip **170** therebetween. The web **30** is supported and transported between the suction roll **90** and the reel nip **170** by a non-contacting support system **220** comprising, for example, one or more air foils, wherein such air foils may be active or passive. The air foils **220** are configured and spaced so as

to provide sufficient support for the web **30** until the web **30** is transferred onto the reel drum **160** and directed into the reel nip **170**. Such a configuration may be particularly advantageous, for example, for a dry end section **10** for a stronger tissue paper web **30** such as, for instance, for forming an industrial tissue or towel. Further, embodiments of the present invention implementing a non-contacting support system **220** allows a measurement device **190**, such as a scanner, to be disposed about either or both surfaces of the web **30** for measuring the desired web properties. In addition, in some embodiments, a web-compressing device may be implemented for compressing the web **30**. Such a web-compressing device comprises a pair of rolls **230** disposed in opposing relation about the web **30**, the rolls **230** defining a nip **240** with the web **30** passing through the nip **240**. In this manner, the web **30** is compression treated on both surfaces thereof. If the configuration shown in **FIG. 6** is appropriate for the desired paper-making process, then the elimination of a fabric between the suction roll **90** and the reel nip **170**, as well as the elimination of components associated with such a fabric, may result in significant cost savings.

According to one advantageous aspect of the present invention, in instances where the web **30** is processed through a web-compressing device, such as a nip having a linear load of between about 200 N/m and about 800 N/m, the dry caliper of the web **30** is reduced by between about 20% and about 50%. More particularly, the dry caliper of the web **30** is reduced to between about 0.15 mm and about 0.4 mm, such that the web **30** has a post-compression density of between about 25 kg/m^3 and about 333.3 kg/m^3.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. For example, the web-compressing device described in various embodiments of the present invention may be configured to form either a hard or a soft nip between the rolls comprising the device, wherein the rolls may be at ambient temperature or heated. For a soft nip web-compressing device, one of the rolls may have a cover comprised of a resilient material such as, for example, rubber. Further, a heated web-compressing device may be advantageous in achieving a more consistent thickness profile across the width of the web. In addition, one skilled in the art will appreciate that the present disclosure

describes and otherwise supports methods associated with embodiments of the present invention such as, for instance, methods for making a tissue with enhanced tactile quality and facilitating reel-up of the tissue in a dry end of a tissue paper-making machine, as described and claimed herein. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.